US009472847B2

(12) **United States Patent**
Lee et al.

(10) **Patent No.: US 9,472,847 B2**
(45) **Date of Patent: Oct. 18, 2016**

(54) **ANTENNA STRUCTURE AND WIRELESS COMMUNICATION DEVICE EMPLOYING SAME**

(71) Applicant: **Chiun Mai Communication Systems, Inc.**, New Taipei (TW)

(72) Inventors: **Yi-Chieh Lee**, New Taipei (TW); **Yen-Hui Lin**, New Taipei (TW)

(73) Assignee: **Chiun Mai Communication Systems, Inc.**, New Taipei (TW)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 110 days.

(21) Appl. No.: **14/066,859**

(22) Filed: **Oct. 30, 2013**

(65) **Prior Publication Data**

US 2014/0354488 A1 Dec. 4, 2014

(30) **Foreign Application Priority Data**

Jun. 3, 2013 (TW) ..... 102119655 A

(51) **Int. Cl.**

H01Q 5/371	(2015.01)
H01Q 21/30	(2006.01)
H01Q 9/04	(2006.01)
H01Q 9/42	(2006.01)
H01Q 1/24	(2006.01)

(52) **U.S. Cl.**

CPC ***H01Q 5/371*** (2015.01); ***H01Q 1/243*** (2013.01); ***H01Q 9/0421*** (2013.01); ***H01Q 9/42*** (2013.01); ***H01Q 21/30*** (2013.01)

(58) **Field of Classification Search**

None

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

7,692,595	B2 *	4/2010	Kim	343/728
8,497,806	B2 *	7/2013	Lai et al.	343/702
2009/0231213	A1 *	9/2009	Ishimiya	343/702
2010/0085270	A1 *	4/2010	Lin	343/859
2010/0188298	A1 *	7/2010	Suzuki et al.	343/702
2012/0212390	A1 *	8/2012	Lan	343/860
2013/0050026	A1 *	2/2013	Vin et al.	343/700 MS

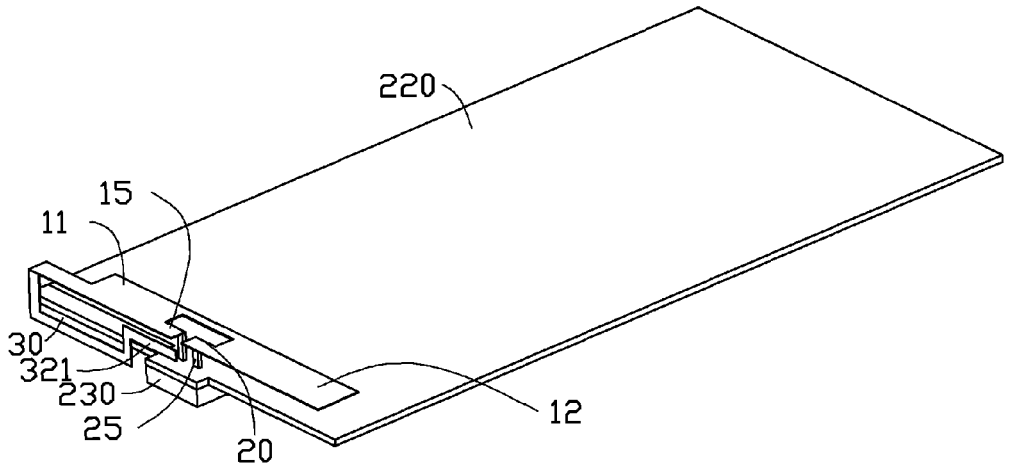
* cited by examiner

Primary Examiner — Robert Karacsony
(74) *Attorney, Agent, or Firm* — Zhigang Ma

(57) **ABSTRACT**

An antenna structure is electronically connected to a connector of a wireless communication device. The connector includes a power terminal and a ground terminal. The antenna structure includes a main antenna, a secondary antenna, and two posts. The main antenna includes a feed portion and a ground portion. The secondary antenna extends from the main antenna. One post electronically connects the power terminal of the connector to the feed portion, and the other post electronically connects the ground terminal of the connector to the ground portion. A wireless communication device employing the antenna structure is also described.

6 Claims, 5 Drawing Sheets



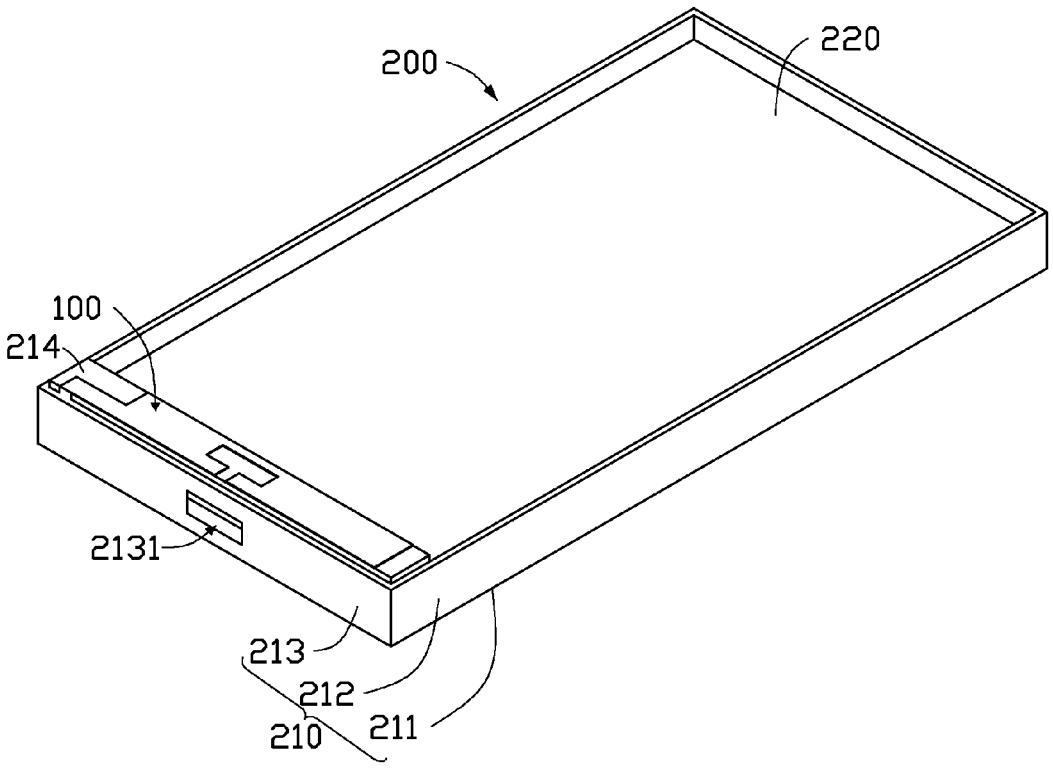


FIG. 1

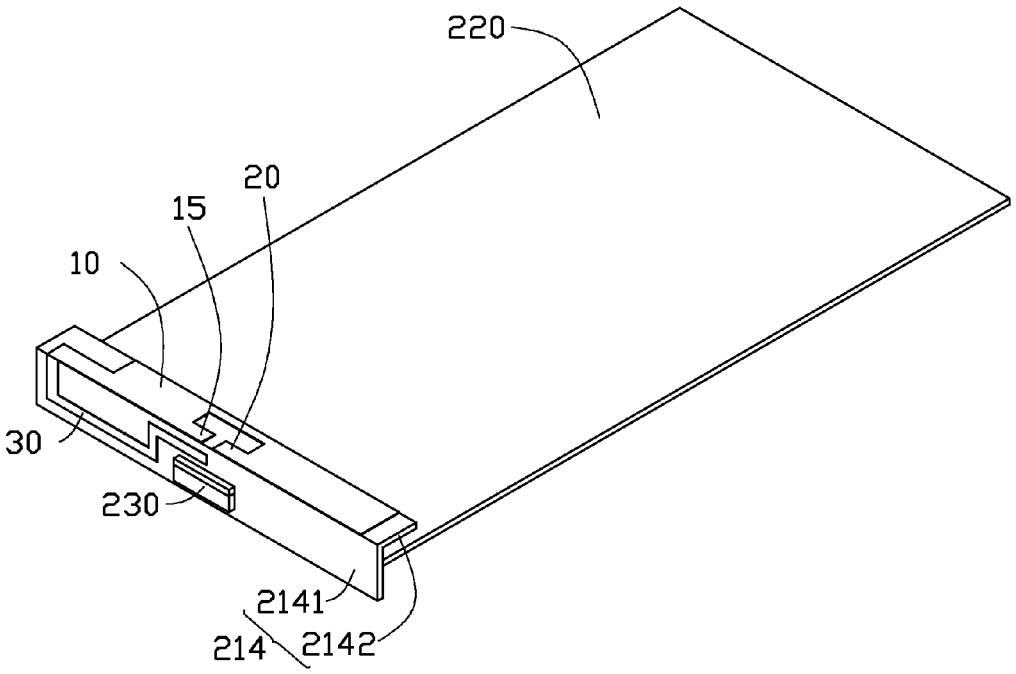


FIG. 2

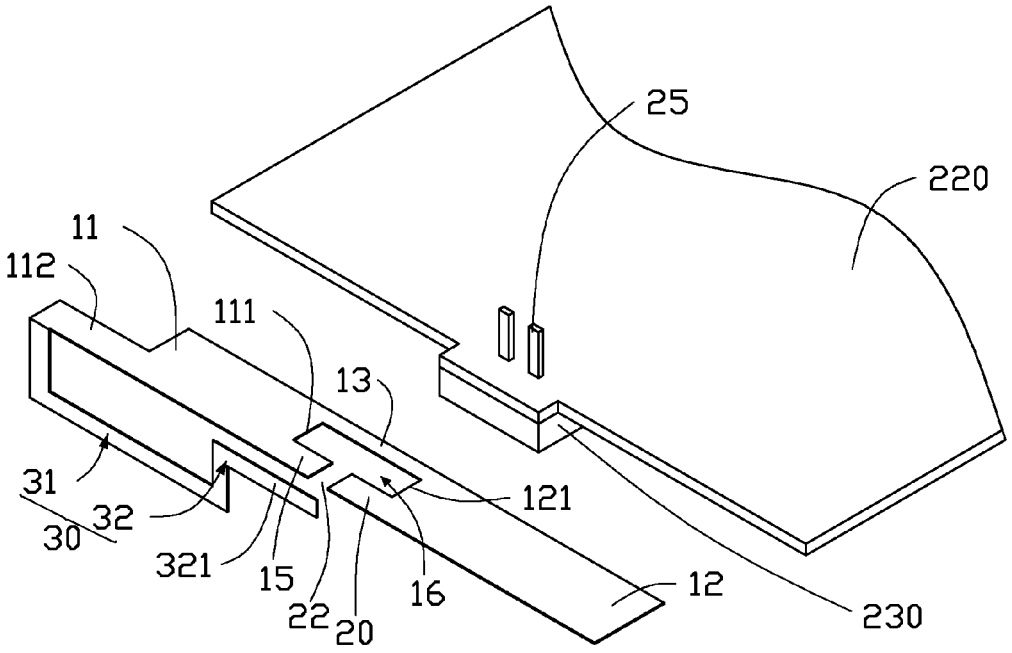


FIG. 3

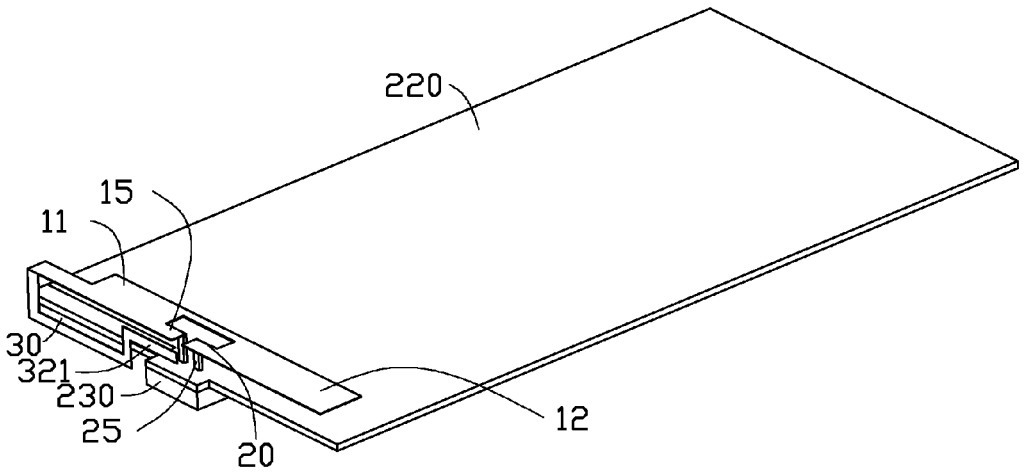


FIG. 4

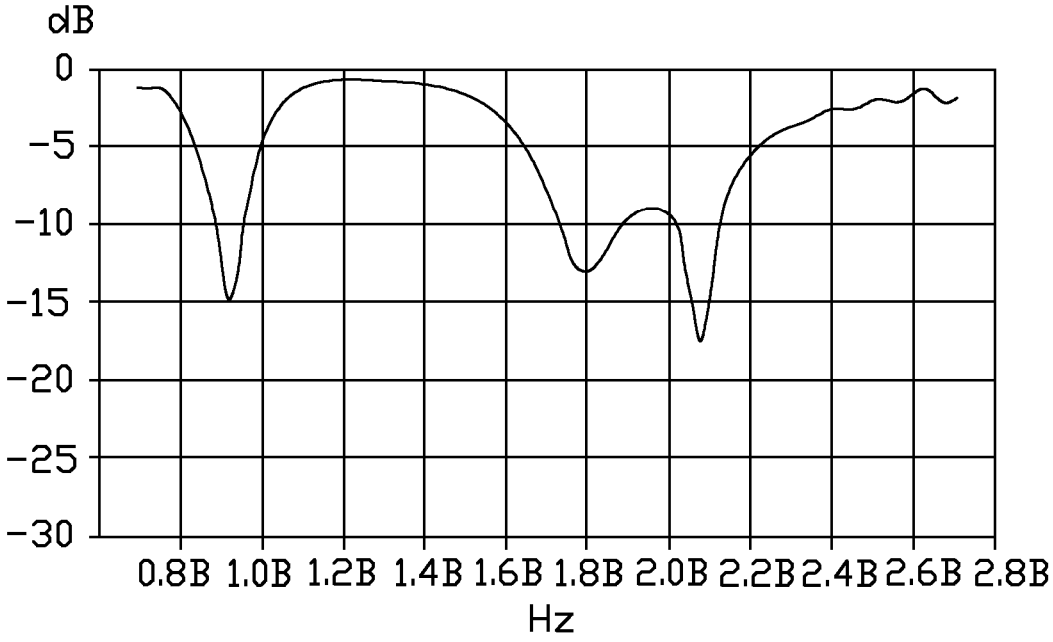


FIG. 5

ANTENNA STRUCTURE AND WIRELESS COMMUNICATION DEVICE EMPLOYING SAME

BACKGROUND

1. Technical Field

The present disclosure relates to an antenna structure and a wireless communication device employing the antenna structure.

2. Description of Related Art

An antenna is used for transceiving wireless signals for a wireless communication device, such as a mobile phone or a personal digital assistant. A space between a circuit board and a frame of a display of the wireless communication device is designated as an antenna clearance zone. However, the available space for the antenna clearance zone is limited because of miniaturization of electronic devices, and a layout and a transmission efficiency of the antenna may be affected. Thus, there are still improvements needed in the art.

BRIEF DESCRIPTION OF THE DRAWINGS

Many aspects of the disclosure can be better understood with reference to the following figures. The components in the figures are not necessarily drawn to scale, the emphasis instead being placed upon clearly illustrating the principles of the disclosure. Moreover, in the drawings, like reference numerals designate corresponding parts throughout the several views.

FIG. **1** is an isometric view of an exemplary embodiment of a wireless communication device having an antenna.

FIG. **2** is an isometric view of the antenna connected to a connector of a circuit board of the wireless communication device of FIG. **1**.

FIG. **3** is an exploded perspective view of the antenna and the circuit board shown in FIG. **2**.

FIG. **4** is a partially assembled perspective view of the antenna and the wireless communication device shown in FIG. **1**.

FIG. **5** is a return loss diagram of the antenna of the wireless communication device.

DETAILED DESCRIPTION

Referring to FIG. **1**, a wireless communication device **200** has an antenna structure **100**, according to an exemplary embodiment. The wireless communication device **200** can be a mobile phone or a tablet computer, for example.

The wireless communication device **200** includes a housing **210**, a circuit board **220**, and a connector **230**. The housing **210** includes a bottom wall **211**, two opposite sidewalls **212**, and two opposite end walls **213**. The sidewalls **212** and the end walls **213** are arranged along peripheral edges of the bottom wall **211**. An opening **2131** is defined in one end wall **213** for receiving and exposing the connector **230**. The circuit board **220** is mounted in the housing **210**. The housing **210** includes a substantially L-shaped carrier **214**. The carrier **214** includes a first board **2141** and a second board **2142** connected substantially perpendicularly to the first board **2141**. The first board **2141** corresponds to the end wall **213** defining the opening **2131**. The second board **2142** is spaced from and parallel with the circuit board **220**, thereby defining a clearance zone between the second board **2142** and the circuit board **220**. In the exemplary embodiment, the connector **230** is a USB connector mounted on an end of the circuit board **220** and received by the opening **2131**. Thus, the connector **230** is exposed from the housing **210**. The second board **2142** is adjacent to the connector **230** and is substantially parallel to the bottom wall **211**. The connector **230** is electronically connected to the circuit board **220** and includes a power terminal (not shown) and a ground terminal (not shown). The power terminal and the ground terminal serve as a feed portion and a ground portion of the antenna structure **100**, respectively, for feeding current and grounding the antenna structure **100**.

Referring to FIG. **3** and FIG. **4**, the antenna structure **100** includes a main antenna **10** (shown in FIG. **2**), a feed portion **15**, a ground portion **20**, two posts **25**, and a secondary antenna **30**. The main antenna **10** is a planar inverted-F antenna (PIFA), which includes a first sheet **11**, a second sheet **12**, and a connecting sheet **13**. The first sheet **11** is coplanar with the second sheet **12**. The first sheet **11** includes a first end **111**, and the second sheet **12** includes a second end **121** corresponding to the first end **111**.

The feed portion **15** is substantially coplanar with the main antenna **10**. The feed portion **15** extends substantially parallel from a side of the first end **111** towards the second end **121** and parallels with the connecting sheet **13**. The ground portion **20** extends substantially parallel from a side of the second end **121** towards the first end **111** and parallel with the connecting sheet **13**. A gap **22** is defined between the feed portion **15** and the ground portion **20**. The feed portion **15**, the first end **111**, the connecting sheet **13**, the second end **121**, and the ground portion **20** cooperatively enclose an opening area **16** communicating with the gap **22**, thereby forming a high frequency resonance path.

The first sheet **11** further includes a frame **112** extending from an end opposite to the first end **111**. The frame **112** is collinear with the feed portion **15**. The two posts **25** are made of conductive metal material. One post **25** electronically connects the power terminal of the connector **230** to the feed portion **15** of the main antenna **10**, while the other post **25** electronically connects to the ground terminal of the connector **230** to the ground portion **20** of the main antenna **10**. Each post **25** penetrates through the second board **2142** to electrically connect to the main antenna **10**.

The secondary antenna **30** is a microstrip and includes a first extending portion **31** and a second extending portion **32**. The first extending portion **31** is coplanar with the second extending portion **32**, and a plane formed by the first extending portion **31** and the second extending portion **32** is perpendicular to a plane of the main antenna **10**. The first extending portion **31** is L-shaped and extends perpendicularly from a free end of the frame **112**, then bends perpendicularly and extends parallel to the first sheet **11**. The second extending portion **32** is L-shaped and extends perpendicularly towards the first sheet **11** from an end portion of the first extending portion **31**, then bends perpendicularly and extends parallel to the first sheet **11**. The second extending portion **32** includes a free end **321**. The free end **321** is spaced from and parallel to the feed portion **15**.

The main antenna **10** is supported by the second board **2142**. The secondary antenna **30** is supported by the first board **2141**. The feed portion **15** and the ground portion **20** are electronically connected to the two posts **25**. Current from the power terminal of the connector **230** transmits to the feed portion **15** through the post **25**, and then transmits to the first sheet **11**, the connecting sheet **13**, the second sheet **12**, the ground portion **20**, the other post **25**, and the ground terminal of the connector **230**, thus forming a first current path. Therefore, the main antenna **10** can operate at a high

frequency resonance mode. The antenna structure **100** receives and transmits wireless signals at a central frequency of about 1700 megaHertz (MHz) to about 2200 MHz. By adjusting sizes and shapes of the first sheet **11**, the second sheet **12**, the connecting sheet **13**, and the opening area **16** during manufacturing, the wireless communication device **200** operates at frequency bands of DCS1800, PCS1900, and WCDMA2100.

In addition, current transmits to the secondary antenna **30** through the first sheet **11** and the second sheet **12**, and flows to the ground terminal of the connector **230** through the post **25**, thus forming a second current path. Therefore, the main antenna **10** can operates at a low frequency resonance mode. The antenna structure **100** receives and transmits wireless signals at a central frequency of about 800 MHz to about 960 MHz. The central frequency of the low frequency resonance mode of the antenna structure **100** is adjusted by adjusting a size or a shape of the secondary antenna **30**, such as by bending.

FIG. **5** is a return loss diagram of the antenna structure **100**, and shows that the antenna structure **100** is operated at GSM 850, EGSM900, DCS 1800, PCS1900, and WCDMA2100 frequency bands.

The antenna structure **100** defines the opening area **16** in the main antenna **10**, and includes the feed portion **15** and the ground portion **20** surrounding the opening area **16**. The antenna structure **100** further includes the secondary antenna **30** and the two posts **25** extending from the main antenna **10**. The two posts **25** are mounted on the connector **230** of the wireless communication device **200** and are electronically connected to the power terminal and the ground terminal of the connector **230**, respectively, thereby reducing a size of the circuit board **220**. The secondary antenna **30** and the main antenna **10** resonate at and generate a low frequency resonance mode and a high frequency resonance mode, respectively, to achieve multiple frequencies of the antenna structure **100**. The antenna structure **100** is mounted in the clearance zone to improve an operating efficiency thereof. In addition, the antenna structure **100** is simple in structure and receives and transmits multi-frequency band signals.

It is believed that the exemplary embodiment and its advantages will be understood from the foregoing description, and it will be apparent that various changes may be made thereto without departing from the spirit and scope of the disclosure or sacrificing all of its advantages, the examples hereinbefore described merely being preferred or exemplary embodiment of the disclosure.

What is claimed is:

1. An antenna structure, electronically connected to a connector of a wireless communication device, the connector comprising a power terminal and a ground terminal, the antenna structure comprising:

a main antenna comprising a feed portion, a ground portion, a first sheet, a second sheet, and a connecting sheet in a plane, the feed portion connected to the first sheet, the ground portion connected to the second sheet, the connecting sheet connected between the first sheet and the second sheet, the feed portion, the first sheet, the connecting sheet, the second sheet, and the ground portion enclosing an opening area communicating with a gap, the gap defined between the feed portion and the ground portion;

a secondary antenna extending from the first sheet of the main antenna; and

two posts, one post electronically connecting the power terminal of the connector to the feed portion, and the other post electronically connecting the ground terminal of the connector to the ground portion;

wherein the main antenna is a planar inverted-F antenna, the secondary antenna includes a first extending portion and a second extending portion coplanar with the first extending portion, a plane of the first extending portion and the second extending portion is perpendicular to a plane of the first sheet and the second sheet;

wherein the first extending portion and the second extending portion both are L-shaped, and connected to each other;

wherein the first sheet includes a junction portion, the first extending portion perpendicularly extends from an end of the junction portion, then bends perpendicularly and extends parallel to the first sheet the second extending portion extends perpendicularly towards the first sheet from an end portion of the first extending portion, then bends perpendicularly and extends parallel to the first sheet;

wherein the first sheet further includes a first end opposite to the junction portion, the second sheet includes a second end, the connecting sheet is connected between a side of the first end and a side of the second end;

wherein the feed portion extends parallel from the side of the first end towards the second end parallel to the connecting sheet, the ground portion extends parallel from the side of the second end towards the first end parallel to the connecting sheet, the feed portion, the first end, the connecting sheet, the second end, and the ground portion enclose the opening area.

2. A wireless communication device, comprising:

a housing;

a connector mounted in the housing and comprising a power terminal and a ground terminal; and

an antenna structure mounted in the housing and comprising:

a main antenna comprising a feed portion, a ground portion, a first sheet, a second sheet, and a connecting sheet in a plane, the feed portion connected to the first sheet, the ground portion connected to the second sheet, the connecting sheet connected between the first sheet and the second sheet, the feed portion, the first sheet, the connecting sheet, the second sheet, and the ground portion enclosing an opening area communicating with a gap, the gap defined between the feed portion and the ground portion;

a secondary antenna extending from the first sheet of the main antenna; and

two posts, one post electronically connecting the power terminal of the connector to the feed portion, and the other post electronically connecting the ground terminal of the connector to the ground portion;

wherein the main antenna is a planar inverted-F antenna, the secondary antenna includes a first extending portion and a second extending portion coplanar with the first extending portion, a plane of the first extending portion and the second extending portion is perpendicular to a plane of the first sheet and the second sheet;

wherein the first extending portion and the second extending portion both are L-shaped, and are connected to each other;

wherein the first sheet includes a junction portion, the first extending portion perpendicularly extends from an end of the junction portion, then bends perpendicularly and extends parallel to the first sheet the second extending portion extends perpendicularly towards the first sheet

from an end portion of the first extending portion, then bends perpendicularly and extends parallel to the first sheet;

wherein the first sheet further includes a first end opposite to the junction portion, the second sheet includes a second end, the connecting sheet is connected between a side of the first end and a side of the second end;

wherein the feed portion extends parallel from the side of the first end towards the second end parallel to the connecting sheet, the ground portion extends parallel from the side of the second end towards the first end parallel to the connecting sheet, the feed portion, the first end, the connecting sheet, the second end, and the ground portion enclose the opening area.

3. The wireless communication device as claimed in claim **2**, further comprising a circuit board mounted in the housing, wherein the connector is mounted on an end of the circuit board.

4. The wireless communication device as claimed in claim **3**, wherein the housing includes an end wall, the end wall defines an opening, the connector is received in the opening and is exposed from the housing.

5. The wireless communication device as claimed in claim **4**, wherein the housing further includes a carrier, the carrier includes a first board and a second board perpendicularly connected to the first board, the second board is parallel with the circuit board, the second board and the circuit board form a clearance zone therebetween, the main antenna is supported by the second board, the secondary antenna is supported by the first board.

6. The wireless communication device as claimed in claim **5**, wherein the posts are made of metal conductive material, one end of the posts pass through the second board and electronically connect to the feed portion and the ground portion.

* * * * *